Manipulation and Charging of Silicon Nanocrystals by Atomic Force Microscopy*

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Si nanocrystal array floating gate MOS structures with approximately one electron stored per nanocrystal are of interest in nonvolatile memories, but are characterized by a distribution of transport properties, which may be related to a dispersion in oxide thicknesses, nanocrystals interface states, or possibly shifts in the electronic bound states due to size variations.

We have developed an aerosol vapor deposition technique for silicon nanocrystal synthesis with active size classification, enabling narrow size distributions (~ 10 \% in 2-10 nm size range). Scanning probe techniques have been used to perform nanocrystal manipulation, to characterize nanocrystal electronic properties and to charge single nanocrystals. Si nanocrystal structures (lines, arrows and other objects) were formed by contact-mode force manipulation, and subsequently imaged in noncontact mode without additional particle motion. Further, single nanocrystal charging by a conducting AFM tip has been observed, indicated as an electrostatic force by apparent height change, followed by a slow relaxation as the stored charge dissipates. Also to be discussed are control of oxide thickness and structure on substrate and nanocrystals.

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